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AUTHOR Stoakes, K. C.; And Others

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ABSTRACT

This instructor's guide, designed for use with the curriculum, Plant Operations for Wastewater Facilities, represents a two-year wastewater technology instructional program based on performance objectives designed to prepare undergraduate students to enter occupations in water and wastewater treatment plant operations and maintenance. This document, part C of five parts, covers the topics of Thickening, First Stage Digestion, Second Stage Digestion and Sludge Conditioning. In this guide, the topics and ideas are presented as a series of modules, organized around 16 general objectives common to all processes. The module begins with a statement of purpose which explains what the student will be studying. Next, all the objectives of the module and code numbers keyed to a computerized list of instructional resources are listed. Also included in each module are a glossary of verbs and sections on learning and testing conditions, acceptable performance, instructor activity and student activity. Recommendations on evaluation techniques are included. (BT)

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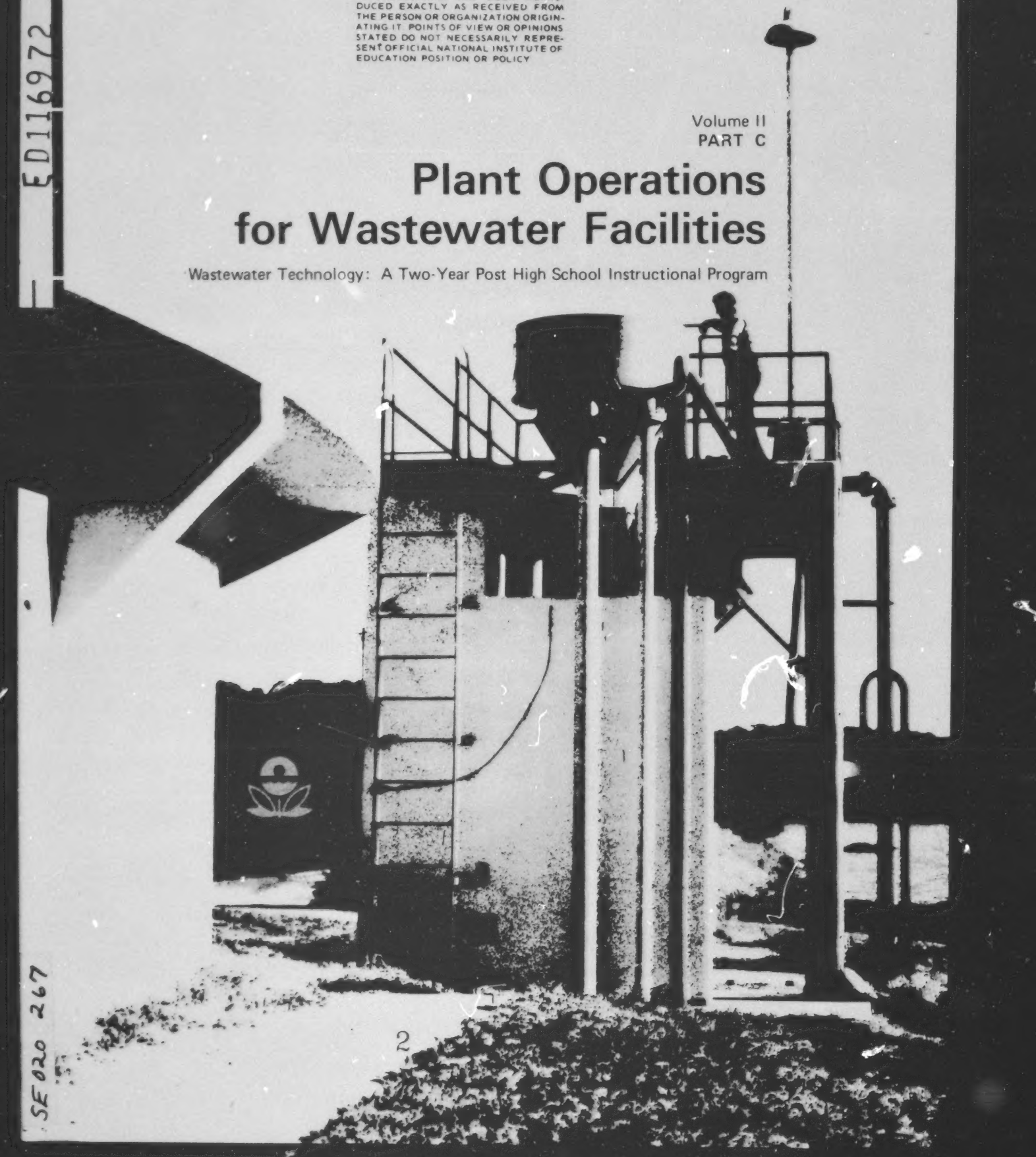
Volume II
PART C

Plant Operations for Wastewater Facilities

Wastewater Technology: A Two-Year Post High School Instructional Program



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PLANT OPERATIONS FOR WASTEWATER FACILITIES, Part C

Thickening
First Stage Digestion
Second Stage Digestion
Sludge Conditioning

An Instructor's Guide for Use of Instructional Material
In Wastewater Technology Training Programs

Funded by

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Water Quality Control Manpower Training Branch
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Academic Training Section
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Washington, DC 20460
703-557-7335

ON PROJECT ADMINISTRATION AND CURRICULA DEVELOPMENT

John H. Austin, Professor and Head
Environmental Systems Engineering
Clemson University
Clemson, South Carolina 29631
803-656-3276

ON PROGRAM IMPLEMENTATION

Carl Schwing
Charles County Community College
La Plata, Maryland 20646
301-934-2251

James L. Chocklett
Greenville Technical College
Greenville, South Carolina 29606
803-242-3170

Peter C. Scott
Linn-Benton Community College
Albany, Oregon 97321
503-928-2361

Preface

Since 1970 Charles County Community College, Clemson University, Greenville Technical College and Linn-Benton Community College have been working together to prepare undergraduate students to enter occupations in water and wastewater treatment plant operations and maintenance. Through their efforts a two-year wastewater technology instructional program based on performance objectives has been developed and implemented.

Through a grant from the Environmental Protection Agency called *Criteria for the Establishment of Two-Year Post High School Wastewater Technology Programs (CEWT)* the four colleges set up program criteria and curriculum guidelines which are available in two volumes:

Program Implementation Procedures
Volume II: Curriculum Guidelines, Criteria for Establishment and Maintenance of Two-Year Post High School Wastewater Technology Programs

As a result of the implementation of the instructional program at Charles County Community College, Greenville Technical College and Linn-Benton Community College, six guides for instructors based on the course descriptions in *Plant Implementation Procedures* and the general criterion behaviors of *Volume II* have been prepared. *Plant Operations for Wastewater Facilities*, printed in five parts, is the second in the series which includes:

Volume I *Introduction to Environmental Technology*
Volume II *Plant Operations for Wastewater Facilities*
Volume III *Laboratory Control for Wastewater Facilities*
Volume IV *Management and Supervision Procedures for Wastewater Facilities*
Volume V *Process Interaction for Wastewater Facilities*
Volume VI *Advanced Waste Treatment*

ACKNOWLEDGEMENTS

Since the beginning of the project many persons at the four cooperating institutions, as well as outside consultants have participated in the development of this program. Their efforts which have provided source material for this guide have been acknowledged in the volumes to which they made major contributions. *Plant Operations for Wastewater Facilities* has been written and produced by:

Technical Staff

K. C. Stoakes, Instructor, Environmental Technology Department, Linn-Benton Community College

John F. Wooley, Instructor, Environmental Technology Department, Linn-Benton Community College
John W. Carnegie, Chairman of Environmental Technology, Linn-Benton Community College
Fred L. Delvecchio, Director of Operator Training, Environmental Systems Engineering, Clemson University
John H. Austin, Professor and Head, Environmental Systems Engineering, Clemson University

Editorial and Production Staff

Ada Louise Steirer, Freelance Editor, Clemson, South Carolina
Marie N. Sims, Project Secretary, Environmental Systems Engineering, Clemson University
Charlotte Holmes, Typing Services, Clemson, South Carolina
Jan Willis, Editorial Assistant, Environmental Systems Engineering, Clemson University
Eleanor McLasky, Typist, Environmental Systems Engineering, Clemson University
Roma Norton, Typist, Environmental Systems Engineering, Clemson University
Linda Flagg, Proofreader, Environmental Systems Engineering, Clemson University

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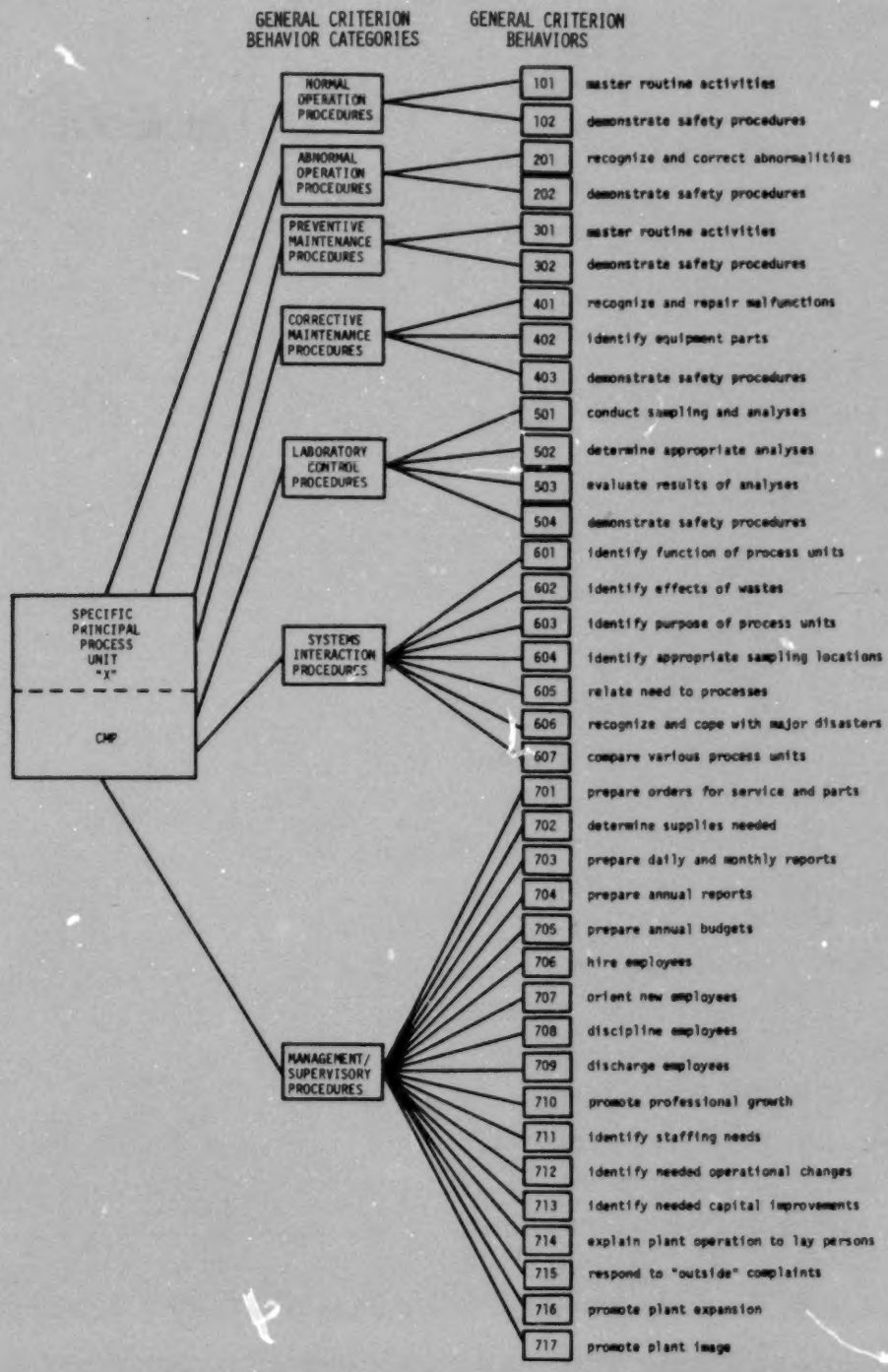
GENERAL CRITERION BEHAVIOR CATEGORIES
GENERAL CRITERION BEHAVIORS
NORMAL OPERATION PROCEDURES
ABNORMAL OPERATION PROCEDURES
PREVENTIVE MAINTENANCE PROCEDURES
CORRECTIVE MAINTENANCE PROCEDURES
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SYSTEMS INTERACTION PROCEDURES
MANAGEMENT/ SUPERVISORY PROCEDURES
SPECIFIC PRINCIPAL PROCESS UNIT "X"
CMP
101 master routine activities
102 demonstrate safety procedures
201 recognize and correct abnormalities
202 demonstrate safety procedures
301 master routine activities
302 demonstrate safety procedures
401 recognize and repair malfunctions
402 identify equipment parts
403 demonstrate safety procedures
501 conduct sampling and analyses
502 determine appropriate analyses
503 evaluate results of analyses
504 demonstrate safety procedures
601 identify function of process units
602 identify effects of wastes
603 identify purpose of process units
604 identify appropriate sampling locations
605 relate need to processes
606 recognize and cope with major disasters
607 compare various process units
701 prepare orders for service and parts
702 determine supplies needed
703 prepare daily and monthly reports
704 prepare annual reports
705 prepare annual budgets
706 hire employees
707 orient new employees
708 discipline employees
709 discharge employees
710 promote professional growth
711 identify staffing needs
712 identify needed operational changes
713 identify needed capital improvements
714 explain plant operation to lay persons
715 respond to "outside" complaints
716 promote plant expansion
717 promote plant image

Figure 1: Relationship of general criterion behaviors (performance objectives) to the general categories and composite model plant (CMP).

Performance Objectives

When the treatment plant operators, educators, consultants and representatives from professional water pollution control organizations came together to develop an effective instructional program, they recommended the use of performance or behavioral objectives because such objectives clearly outline:

1. What the student is expected to do as a result of the instructional program.
2. The conditions under which the student shall do it.
3. The standard of performance.

COMPOSITE MODEL PLANT

First, they developed a composite model plant (CMP) of twenty-two process units which is really many wastewater treatment plants in one model. Such a mix of process units seldom occurs in a treatment plant, but if a student becomes competent in the operation and management of the CMP he should be able to perform successfully in any treatment plant.

TASK ANALYSIS

Next, to ensure that the materials were specifically tailored to what the operator does on the job, a task analysis was conducted. They found that the tasks which an operator performs fell into seven general categories which were further divided into 37 tasks or general behaviors. (See figure 1, page vi.) The tasks were organized under:

1. Normal Operation Procedures. These include routine operating activities that do not vary significantly from day to day and that are designed to keep the plant functioning within a normal range of values. For example, the employee conducts routine samplings of the primary sludge and inspects pumping equipment and the wastestream to verify that the process is functioning properly.

2. Abnormal Operation Procedures. These include activities of the plant employee that result from unusual and undesirable conditions of the wastestream. The abnormal procedures enable the plant employee to recognize when the wastestream is abnormal and to return it to an acceptable, normal condition. An abnormal wastestream results when a normal operation procedure is not properly applied, a corrective maintenance procedure is needed or management/supervisory procedures are poor. For example, the plant employee should recognize that a black septic primary sludge sample is an abnormal condition of the wastestream and take appropriate action.

3. Preventive Maintenance Procedures. These include routine maintenance activities of the plant employee which prevent major equipment breakdown and subsequent corrective maintenance. For example, the employee would lubricate bearings and other moving parts, replace worn components and adjust components of the primary sludge pumps.

4. Corrective Maintenance Procedures. These include maintenance activities of the plant employee that usually result from the breakdown or malfunction of a unit of equipment or a component. For example, the employee would notice whether the primary sludge pump is malfunctioning and know when and how to correct the disorder or when and how to refer the problem to plant maintenance personnel.

5. Laboratory Control Procedures. These include special and routine activities relating to laboratory analysis, the specification of sampling procedures and locations and the general management of the laboratory facilities. For example, the employee would collect primary sludge samples and conduct the analyses.

6. Systems Interaction Procedures. These include activities of the plant employee which relate the functioning of specific units of equipment to other process units and to the system as a whole. For example, the employee would determine how the effective functioning of the primary sludge pumps relates to digester performance.

7. Management/Supervisory Procedures. These include activities relating to employment practices, record keeping, plant operation policy and the establishment of a constructive and realistic rapport between the plant and the community it serves. For example, the employee would keep records on primary sludge pumping, keep an inventory of spare parts and evaluate the adequacy of maintenance procedures by shift personnel.

CURRICULUM DESIGN

After deciding what process equipment an operator must operate and maintain, and finding out what an operator does through the task analysis, they listed the objectives a student must master to successfully operate a treatment plant. For example, the student will describe and perform the normal inspection procedure for the primary sedimentation unit including frequency of inspection, conditions to look for and the actions he should take.

INSTRUCTOR'S GUIDES

The next step was the design of manuals to guide the instructor. In the guides varied learning activities and imaginative innovations which produce more learning than traditional teaching methods are emphasized. The instructional suggestions do not need to be followed slavishly, but should be modified and improved as much as possible.

The instructor's goal is to achieve the objectives of the curriculum by selecting activities which suit the student's needs and help him to master all the information and skills in the course. The most effective learning occurs when the student is a participant in the learning process, not a spectator.

An instructor should use learning activities which approximate the situations which the student will meet *in the treatment plant.* If it is not possible to teach in a treatment plant, *simulated situations* should be set up in the workshop or classroom so that the student can solve rather than discuss problems. *Group discussion* stimulated by *visual materials* is an effective learning technique. Lecturing, however, is inefficient. Because the student is not actively involved during a lecture, the instructor should use lectures sparingly.

Introduction to Modules of Instruction

In this instructor's guide the topics and ideas are presented as a series of modules, organized around the general objectives stated in the course descriptions for Plant Operation I, II, III and IV and the In-Plant Practicum which are found in the *Program Implementation Procedures* of the *CEWT Program*. Each module is designed to help the instructor plan a course of study for the operation of a treatment process using the CMP process unit. Each module is organized around sixteen objectives common to all processes.

The modules in *Plant Operations for Wastewater Facilities* are arranged in the order in which the CMP process units occur in the treatment plant. Each process is identified by a letter of the alphabet and the process unit is described in the heading of the module. If the instructor uses the modules in consecutive order, he and his students will follow the treatment of the wastestream from collection to its discharge into the receiving waters. Each module is designed so it can be used as a minicourse in a treatment process. Instructors are urged to group the modules to suit their individual curriculum needs and instructional situations.

Material in the modules can easily be adapted for courses which upgrade the training of operators in normal operation procedures, abnormal operation procedures, preventive maintenance procedures or corrective maintenance procedures by grouping the appropriate objectives from all the modules. For example, an instructor could develop a course in corrective maintenance by grouping objectives 11 and 12 from each module.

INSTRUCTIONAL PROCESS UNITS

Each module assumes that the composite model plant unit will be used for instruction in the process. If the recommended unit is not available, an alternate process unit may be substituted and the instructional materials adapted. The recommended CMP units and alternate units for all the processes are listed in table 1, page 4. Two modules on sludge dewatering are included because it is impossible for a student to master operation of this process by learning to operate one process unit. Remember, however, that a student will be more adequately prepared to work in almost any treatment plant if he is trained on the CMP unit. When it is not possible to use the recommended unit, students should be informed about the operation and function of the unit and hands-on training should be conducted on the best alternate unit available.

PURPOSE OF THE MODULES

The modules in *Plant Operations for Wastewater Facilities* help the student to learn how to operate all the process units in the wastewater treatment plant. Normal operation, abnormal operation, preventive maintenance and corrective maintenance procedures are included. When the course is completed, he will know why each unit is

TABLE I

SPECIFIC PROCESS UNITS RECOMMENDED FOR USE IN IMPLEMENTATION OF THE TWO-YEAR POST HIGH SCHOOL WASTEWATER TECHNOLOGY INSTRUCTIONAL PROGRAM

Module	Process	CMP Unit	Recommended Teaching Unit	Alternate Teaching Unit
1	Collection	A	Combined system with industrial waste	Sanitary system with industrial waste
2	Chlorination	B	Vacuum chlorinator with automatic feed to pipe, pneumatic control and electric evaporator	Vacuum chlorinator with automatic feed to pipe, electrical control and electric evaporator
		N	Vacuum chlorinator with automatic feed to pipe and closed-loop pneumatic control	Vacuum chlorinator with automatic feed to pipe and closed electrical control
3	Screening and Grinding	C	Mechanically cleaned bubbler control unit with grinder	Mechanically cleaned electrode control unit with grinder
4	Grit Removal	D	Aerated unit with bucket elevator	Aerated unit with screw conveyor
5	Primary Sedimentation	E	Rectangular unit with telescopic valve drawoff, density meter time clock and trough with scraper	Circular unit with telescopic valve drawoff, density meter time clock and trough with scraper
6	Trickling Filtration	F	Rotary distributor, standard rate unit with dosing tank	Rotary distributor, high rate unit
7	Aeration	G	Diffused air unit with swing-type diffuser producing fine bubbles	Mechanical aeration unit with turbine and sparger
8	Secondary Sedimentation	H	Circular, peripheral-feed unit with suction	Circular, center-feed unit with suction
9	Pond Stabilization	I	Aerobic pond	Facultative pond
10	Thickening	J	Floatation unit with air	Floatation unit with vacuum
11	First Stage Digestion	K	Fixed cover, gas recirculation unit with external heat exchanger	Floating cover, gas recirculation unit with external heat exchanger

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12	Second Stage Digestion	L	Floating cover unit with gas storage	Fixed cover unit
13	Sludge Conditioning	M	Chemical conditioning unit with counter-current elutriation	None
14a	Sludge Dewatering	O	Vacuum filter unit with cloth	Vacuum filter unit with coil
14b	Sludge Dewatering	O	Continuous feed centrifuge	None
15	Solids Disposal	P	Multiple hearth incinerator unit	Fluidized bed incinerator unit
16	Effluent Disposal	Q	Direct reuse system	Underground disposal system
17	Flow Measurement	R	Centralized recording and totalizing system including Parshall flume, Venturi meter, magnetic flowmeter and rotameter	None
18	Pumping and Piping	S	System with magnetically connected, pneumatically controlled, diesel driven, centrifugal pumps; speed reducer connected, electrically controlled, motor driven, positive displacement pumps and appropriate piping	None
19	Electric Power	T	System using delta transformers, generators, electrical switchgear, automatic gear, automatic circuit actuators on motors and telemetering with alarms.	System using Y transformers, generators, electrical switchgear, automatic circuit actuators on motors and telemetering with alarms
20	Gas Power	U	System with internally produced gas with high pressure tanks and rotary positive displacement compressors	System with internally produced gas with high pressure tanks and reciprocating compressors

important to the treatment plant and how it affects and interacts with other process units in the treatment system.

STUDENT PREREQUISITES

Completion of Introduction to Environmental Technology and courses in basic mathematics and biology qualify the student to enter the course in Unit Operations for Wastewater Facilities. Concurrent courses in basic chemistry and laboratory control are suggested. (See pages 7 to 19 of *Program Implementation Procedures.*)

TERMINAL OBJECTIVE

When the student has completed the modules of instruction in this course, he should be able to do the following for each of the processes in the treatment plant:

1. Identify the process unit.
2. Describe the process unit in technical and nontechnical terms.
3. Describe the safety procedures for the process unit and explain how the procedures protect employees and visitors.
4. Identify the components of the process unit. Explain the purpose of each component, how the component works and why it is important.
5. Describe the normal operation procedures for the process unit components.
6. Perform the normal operation procedures for the process unit.
7. Describe and perform the start-up and shut-down procedures for the process unit.
8. Describe the abnormal operation procedures for the process unit.
9. Describe the preventive maintenance procedures for the process unit.
10. Perform the preventive maintenance procedures for the process unit.
11. Describe the corrective maintenance procedures for the process unit components.
12. Perform the corrective maintenance procedures for the process unit components.
13. Perform the safety procedures for the process unit and demonstrate how they protect employees and visitors.
14. Compare other process units to the composite model plant unit.
15. Name and locate the components of the process unit. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.
16. Perform the abnormal operation procedures for the process unit.

RESOURCES

The listing of instructional resources suggests materials now available to instructors to accomplish the desired performance in the student.

Instructional materials 1 to 1866 are keyed to the reference, *Instructional Materials Available* which is available from:

Office of Water Program Operations
US Environmental Protection Agency
Washington, DC 20460

Two companion volumes to *Instructional Materials Available*, also available from EPA, offer suggestions for selecting audio-visual equipment:

Selecting Audio-Visual Equipment
Selecting Instructional Media and Instructional Systems

The following journals list addresses of companies from whom literature about the process units which they manufacture can be obtained:

"Environmental Science and Technology"
1155 Sixteenth Street, N.W.
Washington, DC 20036

"Water and Sewage Works"
434 South Wabash
Chicago, IL 60605

"Water and Wastes Engineering"
666 Fifth Avenue
New York, NY 10019

If suitable materials are not available, instructors are urged to develop their own resources.

FORMAT OF THE MODULES

The module begins with a statement of purpose which explains what the student will be studying. Next, all the objectives of the module and code numbers keyed to a computerized list of instructional resources are listed for the instructor's convenience.

Objectives. Each module includes sixteen objectives which bring the student to the performance level required by the terminal objective. The knowledge and skills demanded of the student become more complex as he progresses through the sixteen objectives in a module. He begins by identifying components and learning facts about the components and processes. He uses these facts to develop concepts and ideas. Finally, he relates the concepts and ideas to each other so that he can make decisions about plant procedures.

A glossary of verbs which follows this introduction defines the verbs used in the objectives so that the instructor is aware of what he is instructing the student to do and so that his evaluation of the student is based solely on what is stated in the objective.

Conditions. The conditions define the circumstances under which the student performs and is evaluated and lists the information, equipment and assistance to which the student will have access. The best available learning and testing conditions should be used. A process unit in a treatment plant or workshop has more impact on the students than photographs and drawings. For example, if the student is to be given a process unit, unit components, photographs or diagrams of a unit, the instructor should provide a process unit. If a process unit is not available, he would use components of the unit in combination with photographs of those components which he does not have available. Line drawings and diagrams should not be used if photographs and manufacturers' illustrations are available.

Acceptable Performance. The acceptable performance expands the objective and details the steps a student must follow to reach the objective. To move on to the next objective, at least 70% of each step or category must be mastered with no repeated errors between modules. For example, no student can complete the course of study if he consistently fails to give attention to moving parts as he

performs safety procedures or to describe the odor as he evaluates the characteristics of the wastestream. In this section the instructor will find the main topics of his lesson plan and for the evaluation of the student's performance.

Instructor Activity. The instructor should get to know his class by working with small groups and with each student. He should encourage students to learn from each other as they work together. He should involve the student in the instructional and learning process. Instructional activities are paired numerically with student activities.

Student Activity. This is a listing of activities which the student will take part in, in order to accomplish the specified performance.

EVALUATION TECHNIQUE

The instructor may use or adapt the learning activities listed under instructor activity and student activity as evaluation techniques. The technique chosen should reflect what the objective asks the student to do. For example, if a student is asked to *describe*, the evaluation technique is a *description*. The student should be evaluated under the conditions and to the performance level required for each objective.

Glossary of Verbs

The glossary of verbs is included here so that the instructor will know exactly what the student is being asked to do to meet his objective. Notice the difference, for example, between the meanings of *identify* and *name*. When a student is asked to identify, the instructor is providing the name of the thing to be identified. But, when the student must name something, he must supply the name.

The list includes all the verbs from the objectives and the acceptable performance sections of all the modules, as well as some verbs used in the instructor and student activities.

	DEFINITION	APPLICATION
APPLY	To make use of as suitable, fitting or relevant.	Apply the preventive maintenance schedule for the second stage digestion unit.
CHECK	To inspect and ascertain the condition of, especially in order to determine that the condition is satisfactory.	Check the characteristics of each component.
COMMENT ON	To express an opinion or attitude about what has been seen or heard.	Comment on employee safety procedures.
COMPARE	To examine the character or qualities of, especially for the purpose of discovering resemblances or differences.	Compare other aeration units to the diffused air unit with swing-type diffuser producing fine bubbles.
CONSIDER	To give thought to with a view to purchasing, accepting or adopting.	Consider availability of replacement parts, capital costs, ease of repair, efficiency, maintenance costs, and so forth.
CORRECT	To alter or adjust to bring to some standard or required condition.	Correct the malfunction.
DEMONSTRATE	To illustrate or explain in an orderly and detailed way with many examples, specimens and particulars.	Demonstrate the start-up procedures in a treatment plant.

	DEFINITION	APPLICATION
DESCRIBE	To represent by words written or spoken for the knowledge or understanding of others, to transmit an image of the identifying features, the nature and characteristics of objects, events and actions.	Describe the safety procedures for the screening and grinding unit.
DEVELOP	To produce or generate.	Develop a picture file of first stage digestion units.
DISCUSS	To talk about, to present in detail, to exchange views or information about.	Discuss treatment plant case histories.
EVALUATE	To examine and make a judgement about quality, significance, amount, degree or condition of.	Evaluate the wastestream for abnormal conditions.
EXPLAIN	To make plain or clear, to present in detail.	Explain the purpose of each component, how the component works and why it is important.
IDENTIFY	To establish the identity of, pick out or single out an object in response to its name by pointing, picking up, underlining, marking or other responses.	Identify the components of the chlorination unit.
INDICATE	To state or express without going into detail.	Indicate whether the process unit is used for secondary sedimentation.
INSPECT	To view closely and critically, to determine quality or state, to detect errors or otherwise appraise.	Inspect a treatment plant.
LIST	To enumerate or specify.	List routine calculations for the pond stabilization unit.
LOCATE	To stipulate the position of an object in relation to other objects.	Locate the components of the trickling filtration unit.

	DEFINITION	APPLICATION
NAME	To supply the correct name, in oral or written form, for an object, class of objects, persons, places, conditions or events which are pointed out or described.	Name the components of the primary sedimentation unit.
OBSERVE	To pay careful, directed, analytical attention to.	Observe the thickening process during a plant tour.
PERFORM	To carry out an action or pattern of behavior. (Implies an act for which a process or pattern of movement has already been established, especially one calling for skill or precision, or for the assignment or assumption of responsibility.)	Perform the normal operation procedures for the grit removal unit.
POINT OUT	To indicate the position or direction of, especially by extending a finger toward the thing so indicated, to direct someone's attention to.	Point out characteristics which distinguish the first stage digestion unit from other units.
RECOMMEND	To mention or introduce as being worthy of acceptance, use or trial, to advise.	Recommend procedures to correct the unsafe conditions.
SELECT	To choose something from a number or group usually by fitness, excellence, or other distinguishing feature.	Select the reference materials and tools needed to perform the corrective maintenance.

MODULE 10

THICKENING

A floatation unit with air

Composite Model Plant Unit J

PURPOSE: *In this module the student will learn to perform all the activities in the objectives as they apply to a floatation unit with air. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

OBJECTIVES:

10.1 *Identify the thickening unit.*

10.2 *Describe the thickening process in technical and nontechnical terms.*

10.3 *Describe the safety procedures for the thickening unit and explain how the procedures protect employees and visitors.*

10.4 *Identify the components of a thickening unit. Explain the purpose of each component, how the component works and why it is important.*

10.5 *Describe the normal operation procedures for the thickening unit components listed on page 17.*

10.6 *Perform the normal operation procedures for the thickening unit.*

10.7 *Describe and perform the start-up and shut-down procedures for the thickening unit.*

10.8 *Describe the abnormal operation procedures for the thickening process.*

10.9 *Describe the preventive maintenance procedures for the thickening unit.*

10.10 *Perform the preventive maintenance procedures for the thickening unit.*

10.11 *Describe the corrective maintenance procedures for the thickening unit components listed on page 17.*

10.12 *Perform the corrective maintenance procedures for the thickening unit components.*

10.13 *Perform the safety procedures for the thickening unit and demonstrate how they protect employees and visitors.*

10.14 *Compare other thickening units to the floatation unit with air (composite model plant unit J).*

10.15 *Name and locate the components of the thickening unit listed on page 17. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*

10.16 *Perform the abnormal operation procedures for the thickening unit.*

RESOURCES: 3 116 120 125 141 143 144 307 308 309 316 317 320 321 324 421 459 511 551 552 553 554 937 990 1033 1034 1399

<<<<<<>>>>>>

OBJECTIVE 10.1: *Identify the thickening unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:

Indicate whether the process unit is used for thickening.

INSTRUCTOR ACTIVITY:

1. Point out characteristics which distinguish the thickening unit from other process units.

STUDENT ACTIVITY:

1. Develop a picture file of thickening units. Mark distinguishing characteristics.

<<<<<<>>>>>>

OBJECTIVE 10.2: *Describe the thickening process in technical and non-technical terms.*

CONDITIONS: Given photographs of the thickening unit.

ACCEPTABLE PERFORMANCE: The student will:

Describe the thickening unit, explaining the meaning of:
- floatation device
- sludge dewatering device
- thickener

Describe the purpose of thickening.

Describe how thickening affects:
- first-stage digestion
- second stage digestion
- post-chlorination

sludge dewatering
solids disposal
pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe thickening.
2. Describe the thickening process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the thickening process while viewing photographs, diagrams and slides.
2. Observe and describe the thickening process during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 10.3:

Describe the safety procedures for the thickening unit and explain how the procedures protect employees and visitors.

CONDITIONS:

Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE:

The student will:

Describe the safety procedures for the thickening unit, commenting on:
- High-risk activities
  - lifting heavy objects
  - operating the screw
  - operating the skimmer
  - removing debris from channels
  - working in or near pits
  - working with switches in automatic position
- Sources of danger
  - acid wastes
  - caustic wastes
  - electrical equipment
  - explosive gases
  - gratings
  - high-air-pressure equipment and piping
  - high-water-pressure equipment
  - high pressure blowoff
  - loose handrails
  - moving parts

Sources of danger (continued)
- open doors and covers
- pits
- pump components
- slippery floors and walks
- steps
- tanks
- toxic gases
- weir setting device
- wells

Safety equipment
- explosion proof electrical equipment
- first-aid kit
- ladders
- lockout tags and keys
- protective clothing
- railings
- safety stair treads

Explain how the procedures protect employees and visitors.

INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the thickening unit.
4. Identify sources of danger and high-risk activities pictured in slides.

<<<<<<>>>>>>

OBJECTIVE 10.4: *Identify the components of a thickening unit. Explain the purpose of each component, how the component works and why it is important.*

CONDITIONS: Given a thickening unit, unit components or a diagram, model or photographs of a unit and a list of components.

ACCEPTABLE PERFORMANCE: The student will:

Identify components of the thickening unit and associated equipment:

- air compressor
- butterfly valve
- chain
- control board
- drive belt
- drive chain
- drive motor
- fire-fighting equipment
- first-aid kit
- flight
- gear box
- gear reducer
- overflow weir
- overflow weir adjuster
- pressure gage
- pressure tank
- pressure tank regulator valve
- pulley
- pump
- screw drive motor
- sight glass
- skimmer
- sprocket
- track

Explain the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.

STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

<<<<<<>>>>>>

OBJECTIVE 10.5: *Describe the normal operation procedures for the thickening unit components listed above.*

CONDITIONS: Given a thickening unit or slides or photographs of a thickening unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

ACCEPTABLE PERFORMANCE: The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

agitation	position
color	pressure
corrosion	sound
flow	temperature
motion	velocity
odor	vibration

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:
- making adjustments
- deciding about corrective maintenance
- reporting to supervisors
- reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the thickening process.

List routine calculations for the thickening process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the thickening unit.
2. Describe the normal operation procedures for the thickening unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the thickening unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the thickening unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the thickening unit.
4. Observe and describe the normal operation procedures during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 10.6: *Perform the normal operation procedures for the thickening unit.*

CONDITIONS: Given a thickening unit, the manual of normal operation procedures which the student has developed for the thickening unit and basic references.

ACCEPTABLE PERFORMANCE: The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 10.7: *Describe and perform the start-up and shut-down procedures for the thickening unit.*

CONDITIONS: Given a mock-up, model or photograph of a thickening unit and a thickening unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE: The student will:

Start up and shut down a thickening unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the thickening unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the thickening unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

<<<<<<>>>>>>

OBJECTIVE 10.8: *Describe the abnormal operation procedures for the thickening process.*

CONDITIONS: Given a wastestream in a treatment plant or color photographs of a wastestream, a checklist of the conditions of the wastestream and plant records and reference materials.

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

flow	sludge density
pH	suspended solids

Describe the cause and effect of the abnormal condition.

Explain how often the condition of the wastestream must be checked.

Describe what an operator does if he observes abnormal conditions, including:
- operational changes
- reporting to supervisors
- sampling procedures

Describe how the actions of the operator will improve the condition of the wastestream.

INSTRUCTOR ACTIVITY:

1. Describe and explain the abnormal conditions of the wastestream illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures during a slide show.
4. Describe and explain the abnormal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Evaluate and explain the abnormal conditions of the wastestream which are illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures in a class discussion after a slide show.
4. Evaluate and explain the condition of the wastestream during a plant tour. Describe and explain the abnormal operation procedures.

<<<<<<>>>>>>

OBJECTIVE 10.9: *Describe the preventive maintenance procedures for the thickening unit.*

CONDITIONS: Given a thickening unit or pictures and drawings of a thickening unit and reference materials, including:

- inspection records
- manufacturer's maintenance guides
- plant drawings and specifications
- preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Describe these preventive maintenance procedures for the thickening unit:

Cleaning
- air compressor
- butterfly valve
- chain
- drive belt
- drive chain
- drive motor
- gear box
- gear reducer
- overflow weir
- pressure tank
- pump
- screw drive motor
- sight glass
- skimmer

Lubrication
- air compressor
- chain
- drive motor
- gear box
- gear reducer
- pump
- screw drive motor
- sprocket

Mechanical adjustment
- air compressor
- butterfly valve
- chain
- control board
- drive belt
- drive chain
- drive motor
- flight
- gear box
- gear reducer
- overflow weir
- overflow weir adjuster
- pressure
- pressure tank regulator valve
- pulley
- pump
- screw drive motor
- skimmer
- sprocket

Painting
- air compressor
- drive motor
- gear box
- pressure tank
- pump
- screw drive motor
- skimmer

Replacement
- fire-fighting equipment
- first-aid kit
- gear reducer
- pulley
- sight glass

Wear measurement
- chain
- drive belt
- drive chain
- flight
- skimmer
- sprocket
- track

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the thickening unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 10.10: *Perform the preventive maintenance procedures for the thickening unit.*

CONDITIONS: Given a thickening unit and tools and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the thickening unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 10.11: *Describe the corrective maintenance procedures for the thickening unit components listed on page 17.*

CONDITIONS: Given a thickening unit or a mock-up, photographs or drawings of a thickening unit, the manual of operation procedures which the student has developed for the thickening unit, tools and reference materials, including:

catalogue of replacement parts
equipment catalogues
manufacturer's maintenance guides

ACCEPTABLE PERFORMANCE: The student will:

Describe how an operator evaluates each component of the thickening unit for corrective maintenance, commenting on:

agitation	position
color	pressure
corrosion	sound
flow	temperature
motion	velocity
odor	vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the thickening unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

<<<<<<>>>>>>

OBJECTIVE 10.12: *Perform the corrective maintenance procedures for the thickening unit components.*

CONDITIONS: Given a thickening unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:
- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the components of the thickening unit for corrective maintenance, explaining why a component

has malfunctioned and commenting on:

agitation	position
color	pressure
corrosion	sound
flow	temperature
motion	velocity
odor	vibration

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 10.13: *Perform the safety procedures for the thickening unit and demonstrate how they protect employees and visitors.*

CONDITIONS: Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

ACCEPTABLE PERFORMANCE: The student will:

Identify hazardous conditions in the thickening unit, commenting on:
- high-risk activities

sources of danger
safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 10.14: *Compare other thickening units to the floatation unit with air (composite model plant unit J).*

CONDITIONS: Given a process unit and reference materials, including:
equipment catalogues
laboratory reports
manufacturer's bulletins
manufacturer's operation manuals
plant maintenance and operation records

ACCEPTABLE PERFORMANCE: The student will:

Compare composite model plant unit J with:
a floatation unit with vacuum.
a stirring and settling unit.
a centrifuge unit.

Consider:
availability of replacement parts
capital costs
dependency on surrounding environment
ease of repair
efficiency

flow-handling capabilities
maintenance costs
nuisance to neighbors
operational costs
operational skills
personnel requirements
reliability
resistance to upset
sensitivity of controls
space requirements
waste-handling capabilities

INSTRUCTOR ACTIVITY:

1. Prepare a chart for tabulation of information about the units.
2. Compare the composite model plant unit J with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

<<<<<<>>>>>>

OBJECTIVE 10.15:

Name and locate the components of the thickening unit listed on page 17. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given a thickening unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the thickening unit
manufacturer's maintenance guides
operation and maintenance manuals

ACCEPTABLE PERFORMANCE:

The student will:

Name and locate the components of the thickening unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the thickening unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the thickening unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the thickening unit and normal operation procedures.

<<<<<<>>>>>>

OBJECTIVE 10.16: *Perform the abnormal operation procedures for the thickening unit.*

CONDITIONS: Given a wastestream in a treatment plant and reference materials, including:

industrial waste records
operation logs
operator manuals
plant performance guides

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

flow	sludge density
pH	suspended solids

Select the references he needs to return the wastestream to normal.

Perform the abnormal operation procedures.

INSTRUCTOR ACTIVITY:

1. Observe the student as he evaluates the wastestream in a treatment plant.
2. Describe the references needed to correct abnormal conditions of the wastestream.
3. Observe the student performing the abnormal operation procedures in simulated situations and in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate the wastestream in a treatment plant.
2. Select the references needed to correct abnormal conditions of the wastestream.
3. Perform the abnormal operation procedures in simulated situations or in a treatment plant.

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MODULE 11

FIRST STAGE DIGESTION

A fixed-cover gas recirculation unit with external heat exchanger

Composite Model Plant Unit K

PURPOSE: *In this module the student will learn to perform all the activities in the objectives as they apply to a fixed-cover gas recirculation unit with external heat exchanger. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

OBJECTIVES:

11.1 *Identify the first stage digestion unit.*

11.2 *Describe the first stage digestion process in technical and nontechnical terms.*

11.3 *Describe the safety procedures for the first stage digestion unit and explain how the procedures protect employees and visitors.*

11.4 *Identify the components of a first stage digestion unit. Explain the purpose of each component, how the component works and why it is important.*

11.5 *Describe the normal operation procedures for the first stage digestion unit components listed on page 35.*

11.6 *Perform the normal operation procedures for the first stage digestion unit.*

11.7 *Describe and perform the start-up and shut-down procedures for the first stage digestion unit.*

11.8 *Describe the abnormal operation procedures for the first stage digestion process.*

11.9 *Describe the preventive maintenance procedures for the first stage digestion unit.*

11.10 *Perform the preventive maintenance procedures for the first stage digestion unit.*

11.11 *Describe the corrective maintenance procedures for the first stage digestion unit components listed on page 35.*

11.12 *Perform the corrective maintenance procedures for the first stage digestion unit components.*

11.13 *Perform the safety procedures for the first stage digestion unit and demonstrate how they protect employees and visitors.*

11.14 *Compare other first stage digestion units to the fixed-cover gas recirculation unit with external heat exchanger (composite model plant unit K).*

11.15 *Name and locate the components of the first stage digestion unit listed on page 35. Name and select reference materials*

which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

11.16 *Perform the abnormal operation procedures for the first stage digestion unit.*

RESOURCES: 3 116 120 125 126 141 143 144 185 307 308 309 314 315 316 317 320 321 324 421 459 511 551 552 553 554 937 990 1033 1034 1399

<<<<<<>>>>>>

OBJECTIVE 11.1: *Identify the first stage digestion unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:

Indicate whether the process unit is used for first stage digestion.

INSTRUCTOR ACTIVITY:

1. Point out characteristics which distinguish the first stage digestion unit from other process units.

STUDENT ACTIVITY:

1. Develop a picture file of first stage digestion units. Mark distinguishing characteristics.

<<<<<<>>>>>>

OBJECTIVE 11.2: *Describe the first stage digestion process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the first stage digestion unit.

ACCEPTABLE PERFORMANCE: The student will:

Describe the first stage digestion unit, explaining the meaning of:
anaerobic digester

digester
digestion tank
sludge digester

Describe the purpose of first stage digestion.

Describe how first stage digestion affects:
second stage digestion
pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe first stage digestion.
2. Describe the first stage digestion process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the first stage digestion process while viewing photographs, diagrams and slides.
2. Observe and describe the first stage digestion process during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 11.3: *Describe the safety procedures for the first stage digestion unit and explain how the procedures protect employees and visitors.*

CONDITIONS: Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE: The student will:

Describe the safety procedures for the first stage digestion unit, commenting on:
High-risk activities
opening digester cover access hatches
removing debris from channels
working with switches in automatic position
Sources of danger
acid wastes
boiler
caustic wastes
deep wells
electrical equipment
explosive gases
gas recirculation equipment

Sources of danger (continued)
- heat exchanger
- moving parts
- open doors and covers
- pressure-vacuum safety valve
- slippery walks
- toxic gases
- welding torch

Safety equipment
- fire-fighting equipment
- first-aid kit
- gas mask
- lockout tags and keys
- no smoking sign
- nonsparking tools
- protective clothing
- railings
- stair safety treads

Explain how the procedures protect employees and visitors.

INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the first stage digestion unit.
4. Identify sources of danger and high-risk activities pictured in slides.

<<<<<<>>>>>>

OBJECTIVE 11.4: *Identify the components of a first stage digestion unit. Explain the purpose of each component, how the component works and why it is important.*

CONDITIONS: Given a first stage digestion unit, unit components or a diagram, model or photographs of a unit and a list of components.

ACCEPTABLE PERFORMANCE: The student will:

Identify components of the first stage digestion unit and associated equipment:

- boiler
- fire-fighting equipment
- first-aid kit
- gas recirculation unit
  - compressor
  - oiler
  - pressure gage
  - valve
  - valve timer
- manometer
- meter
- motor
- piping
- pressure relief valve
- recirculation pump
- sludge pump
- switchgear
- vacuum relief valve
- water trap

Explain the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.

STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

<<<<<<>>>>>>

OBJECTIVE 11.5: *Describe the normal operation procedures for the first stage digestion unit components listed above.*

CONDITIONS: Given a first stage digestion unit or slides or photographs of a first stage digestion unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

ACCEPTABLE PERFORMANCE: The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vacuum
position	vibration

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:

- making adjustments
- deciding about corrective maintenance
- reporting to supervisors
- reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the first stage digestion process.

List routine calculations for the first stage digestion process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the first stage digestion unit.
2. Describe the normal operation procedures for the first stage digestion unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the first stage digestion unit.
4. Describe and explain the normal operation procedures

during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the first stage digestion unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the first stage digestion unit.
4. Observe and describe the normal operation procedures during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 11.6: *Perform the normal operation procedures for the first stage digestion unit.*

CONDITIONS: Given a first stage digestion unit, the manual of normal operation procedures which the student has developed for the first stage digestion unit and basic references.

ACCEPTABLE PERFORMANCE: The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.

2. Perform and explain the normal operation procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 11.7: *Describe and perform the start-up and shut-down procedures for the first stage digestion unit.*

CONDITIONS: Given a mock-up, model or photograph of a first stage digestion unit and a first stage digestion unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE: The student will:

Start up and shut down a first stage digestion unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the first stage digestion unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the first stage digestion unit to determine whether correct shut-down

procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

<<<<<<>>>>>>

OBJECTIVE 11.8: *Describe the abnormal operation procedures for the first stage digestion process.*

CONDITIONS: Given a wastestream in a treatment plant or color photographs of a wastestream, a checklist of the conditions of the wastestream and plant records and reference materials.

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

- acidity
- alkalinity
- ammonia nitrogen
- flow
- gas composition
- industrial wastes
- level
- odor
- organic and total Kjedahl nitrogen
- pH
- sludge density
- temperature
- toxic gases
- volatile acids

Describe the cause and effect of the abnormal condition.

Explain how often the condition of the wastestream must be checked.

Describe what an operator does if he observes abnormal conditions, including:

- operational changes
- reporting to supervisors
- sampling procedures

Describe how the actions of the operator will improve the condition of the wastestream.

INSTRUCTOR ACTIVITY:

1. Describe and explain the abnormal conditions of the wastestream illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.

3. Describe and explain the abnormal operation procedures during a slide show.
4. Describe and explain the abnormal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Evaluate and explain the abnormal conditions of the wastestream which are illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures in a class discussion after a slide show.
4. Evaluate and explain the condition of the wastestream during a plant tour. Describe and explain the abnormal operation procedures.

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OBJECTIVE 11.9: *Describe the preventive maintenance procedures for the first stage digestion unit.*

CONDITIONS: Given a first stage digestion unit or pictures and drawings of a first stage digestion unit and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Describe these preventive maintenance procedures for the first stage digestion unit:

Cleaning
- gas recirculation unit
  - compressor
  - oiler
- manometer
- meter
- motor
- pressure relief valve
- recirculation pump
- sludge pump
- vacuum relief valve
- water trap

Lubrication
- gas recirculation unit
  - compressor
  - oiler
- motor
- pressure relief valve
- recirculation pump
- sludge pump

vacuum relief valve	vacuum relief valve
Mechanical adjustment	Painting
boiler	boiler
gas recirculation unit	gas recirculation unit
compressor	compressor
oiler	oiler
pressure gage	motor
valve	piping
valve timer	recirculation pump
manometer	sludge pump
motor	Replacement
pressure relief valve	fire-fighting equipment
recirculation pump	first-aid kit
switchgear	manometer
sludge pump	meter

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the first stage digestion unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

<<<<<<>>>>>>

OBJECTIVE 11.10: *Perform the preventive maintenance procedures for the first stage digestion unit.*

CONDITIONS: Given a first stage digestion unit and tools and reference materials, including:
- inspection records
- manufacturer's maintenance guides
- plant drawings and specifications
- preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the first stage digestion unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

INSTRUCTOR ACTIVITY:
1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

STUDENT ACTIVITY:
1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

<<<<<<>>>>>>

OBJECTIVE 11.11: *Describe the corrective maintenance procedures for the first stage digestion unit components listed on page 35.*

CONDITIONS: Given a first stage digestion unit or a mock-up, photographs or drawings of a first stage digestion unit, the manual of operation procedures which the student has developed for the first stage digestion unit, tools and reference materials, including:
- catalogue of replacement parts

equipment catalogues
manufacturer's maintenance guides

ACCEPTABLE PERFORMANCE: The student will:

Describe how an operator evaluates each component of the first stage digestion unit for corrective maintenance, commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vacuum
position	vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the first stage digestion unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

<<<<<<>>>>>>

OBJECTIVE 11.12: *Perform the corrective maintenance procedures for the first stage digestion unit components.*

CONDITIONS: Given a first stage digestion unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:
- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the components of the first stage digestion unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vacuum
position	vibration

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:
- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

INSTRUCTOR ACTIVITY:
1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.
3. Observe the student performing the corrective maintenance procedures in a treatment plant.

STUDENT ACTIVITY:
1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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OBJECTIVE 11.13: *Perform the safety procedures for the first stage digestion unit and demonstrate how they protect employees and visitors.*

CONDITIONS: Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

ACCEPTABLE PERFORMANCE: The student will:

Identify hazardous conditions in the first stage digestion unit, commenting on:
- high-risk activities
- sources of danger
- safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:
1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:
1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 11.14: *Compare other first stage digestion units to the fixed-cover gas recirculation unit with external heat exchanger (composite model plant unit K).*

CONDITIONS: Given a process unit and reference materials, including:
- equipment catalogues
- laboratory reports

manufacturer's bulletins
manufacturer's operation manuals
plant maintenance and operation records

ACCEPTABLE PERFORMANCE: The student will:

Compare composite model plant unit K with:
- a floating-cover gas recirculation unit with external heat exchanger.
- an aerobic digester unit.
- a fixed-cover unit with turbo mix.
- a fixed-cover unit with hot water coil heat.

Consider:
- availability of replacement parts
- capital costs
- dependency on surrounding environment
- ease of repair
- efficiency
- flow-handling capabilities
- maintenance costs
- nuisance to neighbors
- operational costs
- operational skills
- personnel requirements
- reliability
- resistance to upset
- sensitivity of controls
- space requirements
- waste-handling capabilities

INSTRUCTOR ACTIVITY:

1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit K with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

<<<<<<>>>>>>

OBJECTIVE 11.15: *Name and locate the components of the first stage digestion unit listed on page 35. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.*

CONDITIONS: Given a first stage digestion unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the first stage digestion unit
manufacturer's maintenance guides
operation and maintenance manuals

ACCEPTABLE PERFORMANCE: The student will:

Name and locate the components of the first stage digestion unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the first stage digestion unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the first stage digestion unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the first stage digestion unit and normal operation procedures.

<<<<<<>>>>>>

OBJECTIVE 11.16: *Perform the abnormal operation procedures for the first stage digestion unit.*

CONDITIONS:

Given a wastestream in a treatment plant and reference materials, including:

- industrial waste records
- operation logs
- operator manuals
- plant performance guides

ACCEPTABLE PERFORMANCE:

The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

- acidity
- alkalinity
- ammonia nitrogen
- flow
- gas composition
- industrial wastes
- level
- odor
- organic and total Kjedahl nitrogen
- pH
- sludge density
- temperature
- toxic gases
- volatile acids

Select the references he needs to return the wastestream to normal.

Perform the abnormal operation procedures.

INSTRUCTOR ACTIVITY:

1. Observe the student as he evaluates the wastestream in a treatment plant.
2. Describe the references needed to correct abnormal conditions of the wastestream.
3. Observe the student performing the abnormal operation procedures in simulated situations and in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate the wastestream in a treatment plant.
2. Select the references needed to correct abnormal conditions of the wastestream.
3. Perform the abnormal operation procedures in simulated situations or in a treatment plant.

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MODULE 12

SECOND STAGE DIGESTION

A floating-cover unit with gas storage

Composite Model Plant Unit L

PURPOSE: *In this module the student will learn to perform all the activities in the objectives as they apply to a floating-cover unit with gas storage. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

OBJECTIVES:

12.1 *Identify the second stage digestion unit.*

12.2 *Describe the second stage digestion process in technical and nontechnical terms.*

12.3 *Describe the safety procedures for the second stage digestion unit and explain how the procedures protect employees and visitors.*

12.4 *Identify the components of a second stage digestion unit. Explain the purpose of each component, how the component works and why it is important.*

12.5 *Describe the normal operation procedures for the second stage digestion unit components listed on page 53.*

12.6 *Perform the normal operation procedures for the second stage digestion unit.*

12.7 *Describe and perform the start-up and shut-down procedures for the second stage digestion unit.*

12.8 *Describe the abnormal operation procedures for the second stage digestion process.*

12.9 *Describe the preventive maintenance procedures for the second stage digestion unit.*

12.10 *Perform the preventive maintenance procedures for the second stage digestion unit.*

12.11 *Describe the corrective maintenance procedures for the second stage digestion unit components listed on page 53.*

12.12 *Perform the corrective maintenance procedures for the second stage digestion unit components.*

12.13 *Perform the safety procedures for the second stage digestion unit and demonstrate how they protect employees and visitors.*

12.14 *Compare other second stage digestion units to the floating-cover unit with gas storage (composite model plant unit L).*

12.15 *Name and locate the components of the second stage digestion unit listed on page 53. Name and select reference materials*

which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

12.16 Perform the abnormal operation procedures for the second stage digestion unit.

RESOURCES: 3 116 120 125 126 141 143 144 185 307 308 309 314 315 316 317 320 321 324 421 459 511 551 552 553 554 937 990 1033 1034 1399

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OBJECTIVE 12.1: *Identify the second stage digestion unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:

Indicate whether the process unit is used for second stage digestion.

INSTRUCTOR ACTIVITY:

1. Point out characteristics which distinguish the second stage digestion unit from other process units.

STUDENT ACTIVITY:

1. Develop a picture file of second stage digestion units. Mark distinguishing characteristics.

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OBJECTIVE 12.2: *Describe the second stage digestion process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the second stage digestion unit.

ACCEPTABLE PERFORMANCE: The student will:

Describe the second stage digestion unit, explaining the meaning of:
anaerobic digester

digester
digestion tank
sludge digester

Describe the purpose of second stage digestion.

Describe how second stage digestion affects:
sludge conditioning
sludge dewatering
solids disposal
flow measurement
pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe second stage digestion.
2. Describe the second stage digestion process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the second stage digestion process while viewing photographs, diagrams and slides.
2. Observe and describe the second stage digestion process during a plant tour.

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OBJECTIVE 12.3: *Describe the safety procedures for the second stage digestion unit and explain how the procedures protect employees and visitors.*

CONDITIONS: Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE: The student will:

Describe the safety procedures for the second stage digestion unit, commenting on:
High-risk activities
opening digester cover access hatches
removing debris from channels
working near sources of gas leakage
working with switches in automatic position
Sources of danger
acid wastes
caustic wastes
deep wells

Sources of danger (continued)
- electrical equipment
- explosive gases
- fire
- moving parts
- open doors and covers
- slippery walks
- toxic gases
- welding torch

Safety equipment
- explosion proof electrical fixtures
- fire-fighting equipment
- first-aid kit
- flame arrester
- flame trap
- gas masks
- handrails
- no smoking signs
- nonsparking hand tools
- pressure relief valve
- protective clothing
- safety treads on ladders and stairs
- vacuum relief valve
- vents

Explain how the procedures protect employees and visitors.

INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.
2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the second stage digestion unit.

4. Identify sources of danger and high-risk activities pictured in slides.

<<<<<<>>>>>>

OBJECTIVE 12.4: *Identify the components of a second stage digestion unit. Explain the purpose of each component, how the component works and why it is important.*

CONDITIONS: Given a second stage digestion unit, unit components or a diagram, model or photographs of a unit and a list of components.

ACCEPTABLE PERFORMANCE: The student will:

Identify components of the second stage digestion unit and associated equipment:

boiler	manometer
fire-fighting equipment	meter
first-aid kit	motor
floating cover	piping
gas recirculation unit	pressure relief valve
compressor	recirculation pump
oiler	sludge pump
pressure gage	switchgear
valve	vacuum relief valve
valve timer	water trap

Explain the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.
4. Question the students about the purpose of each component, how the component works and why it is important.

STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.

3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

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OBJECTIVE 12.5: *Describe the normal operation procedures for the second stage digestion unit components listed on page 53.*

CONDITIONS: Given a second stage digestion unit or slides or photographs of a second stage digestion unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

ACCEPTABLE PERFORMANCE: The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vacuum
position	vibration

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:
- making adjustments
- deciding about corrective maintenance
- reporting to supervisors
- reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the second stage digestion process.

List routine calculations for the second stage digestion process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the second stage digestion unit.
2. Describe the normal operation procedures for the second stage digestion unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the second stage digestion unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the second stage digestion unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the second stage digestion unit.
4. Observe and describe the normal operation procedures during a plant tour.

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OBJECTIVE 12.6: *Perform the normal operation procedures for the second stage digestion unit.*

CONDITIONS: Given a second stage digestion unit, the manual of normal operation procedures which the student has developed for the second stage digestion unit and basic references.

ACCEPTABLE PERFORMANCE: The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

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OBJECTIVE 12.7: *Describe and perform the start-up and shut-down procedures for the second stage digestion unit.*

CONDITIONS: Given a mock-up, model or photograph of a second stage digestion unit and a second stage digestion unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE: The student will:

Start up and shut down a second stage digestion unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.

4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the second stage digestion unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the second stage digestion unit to determine whether correct shut-down procedures have been used. Use the normal operations procedure manual which the student has developed. (See objective 1.4.)

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OBJECTIVE 12.8: *Describe the abnormal operation procedures for the second stage digestion process.*

CONDITIONS: Given a wastestream in a treatment plant or color photographs of a wastestream, a checklist of the conditions of the wastestream and plant records and reference materials.

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

- acidity
- alkalinity
- ammonia nitrogen
- BOD
- COD
- flow
- gas composition
- industrial wastes level
- odor
- organic and total Kjedahl nitrogen
- pH
- sludge density
- temperature
- toxic gases
- volatile acids

Describe the cause and effect of the abnormal condition.

Explain how often the condition of the wastestream must be checked.

Describe what an operator does if he observes abnormal conditions, including:

- operational changes
- reporting to supervisors
- sampling procedures

Describe how the actions of the operator will improve the condition of the wastestream.

INSTRUCTOR ACTIVITY:

1. Describe and explain the abnormal conditions of the wastestream illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures during a slide show.
4. Describe and explain the abnormal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Evaluate and explain the abnormal conditions of the wastestream which are illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures in a class discussion after a slide show.
4. Evaluate and explain the condition of the wastestream during a plant tour. Describe and explain the abnormal operation procedures.

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OBJECTIVE 12.9: *Describe the preventive maintenance procedures for the second stage digestion unit.*

CONDITIONS: Given a second stage digestion unit or pictures and drawings of a second stage digestion unit and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Describe these preventive maintenance procedures for the second stage digestion unit:

Cleaning
- gas recirculation unit
  - compressor
  - oiler
- manometer
- meter
- motor
- pressure relief valve
- recirculation pump
- sludge pump
- vacuum relief valve
- water trap

Lubrication
- gas recirculation unit
  - compressor
  - oiler
- motor
- pressure relief valve
- recirculation pump
- sludge pump
- vacuum relief valve

Mechanical adjustment
- boiler
- floating cover
- gas recirculation unit
  - compressor
  - oiler
- pressure gage
- valve
- valve timer
- manometer
- motor
- pressure relief valve
- recirculation pump
- sludge pump
- switchgear
- vacuum relief valve

Painting
- boiler
- floating cover
- gas recirculation unit
  - compressor
  - oiler
- motor
- piping
- recirculation pump
- sludge pump

Replacement
- fire-fighting equipment
- first-aid kit
- manometer
- meter

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the second stage digestion unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

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OBJECTIVE 12.10: *Perform the preventive maintenance procedures for the second stage digestion unit.*

CONDITIONS: Given a second stage digestion unit and tools and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the second stage digestion unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

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OBJECTIVE 12.11: *Describe the corrective maintenance procedures for the second stage digestion unit components listed on page 53.*

CONDITIONS: Given a second stage digestion unit or a mock-up, photographs or drawings of a second stage digestion unit, the manual of operation procedures which the student has developed for the second stage digestion unit, tools and reference materials, including:

- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides

ACCEPTABLE PERFORMANCE: The student will:

Describe how an operator evaluates each component of the second stage digestion unit for corrective maintenance, commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vacuum
position	vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the second stage digestion unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

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OBJECTIVE 12.12: *Perform the corrective maintenance procedures for the second stage digestion unit components.*

CONDITIONS: Given a second stage digestion unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:

- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the components of the second stage digestion unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

color	pressure
corrosion	sound
motion	temperature
odor	vacuum
position	vibration

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.

3. Observe the student performing the corrective maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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OBJECTIVE 12.13: *Perform the safety procedures for the second stage digestion unit and demonstrate how they protect employees and visitors.*

CONDITIONS: Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

ACCEPTABLE PERFORMANCE: The student will:

Identify hazardous conditions in the second stage digestion unit, commenting on:
- high-risk activities
- sources of danger
- safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.

2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.
3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 12.14: *Compare other second stage digestion units to the floating-cover unit with gas storage (composite model plant unit L).*

CONDITIONS: Given a process unit and reference materials, including:
- equipment catalogues
- laboratory reports
- manufacturer's bulletins
- manufacturer's operation manuals
- plant maintenance and operation records

ACCEPTABLE PERFORMANCE: The student will:

Compare composite model plant unit L with:
- a fixed-cover unit.
- an aerobic digester unit.

Consider:
- availability of replacement parts
- capital costs
- dependency on surrounding environment
- ease of repair
- efficiency
- flow-handling capabilities
- maintenance costs
- nuisance to neighbors
- operational costs
- operational skills
- personnel requirements
- reliability
- resistance to upset
- sensitivity of controls
- space requirements
- waste-handling capabilities

INSTRUCTOR ACTIVITY:
1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit L with the other units.

3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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OBJECTIVE 12.15:

Name and locate the components of the second stage digestion unit listed on page 53. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given a second stage digestion unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the second stage digestion unit
manufacturer's maintenance guides
operation and maintenance manuals

ACCEPTABLE PERFORMANCE:

The student will:

Name and locate the components of the second stage digestion unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the second stage digestion unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the second stage digestion unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.

2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which describe the second stage digestion unit and normal operation procedures.

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OBJECTIVE 12.16: *Perform the abnormal operation procedures for the second stage digestion unit.*

CONDITIONS: Given a wastestream in a treatment plant and reference materials, including:

- industrial waste records
- operation logs
- operator manuals
- plant performance guides

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

- acidity
- alkalinity
- ammonia nitrogen
- BOD
- COD
- flow
- gas composition
- industrial wastes level
- odor
- organic and total Kjedahl nitrogen
- pH
- sludge density
- temperature
- toxic gases
- volatile acids

Select the references he needs to return the wastestream to normal.

Perform the abnormal operation procedures.

INSTRUCTOR ACTIVITY:

1. Observe the student as he evaluates the wastestream in a treatment plant.
2. Describe the references needed to correct abnormal conditions of the wastestream.
3. Observe the student performing the abnormal operation procedures in simulated situations and in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate the wastestream in a treatment plant.
2. Select the references needed to correct abnormal conditions of the wastestream.
3. Perform the abnormal operation procedures in simulated situations or in a treatment plant.

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MODULE 13

SLUDGE CONDITIONING

A chemical conditioning unit with countercurrent elutriation

Composite Model Plant Unit M

PURPOSE: *In this module the student will learn to perform all the activities in the objectives as they apply to a chemical conditioning unit with countercurrent elutriation. READ PAGES 1 TO 11 BEFORE USING THIS MODULE.*

OBJECTIVES:

13.1 *Identify the sludge conditioning unit.*

13.2 *Describe the sludge conditioning process in technical and non-technical terms.*

13.3 *Describe the safety procedures for the sludge conditioning unit and explain how the procedures protect employees and visitors.*

13.4 *Identify the components of a sludge conditioning unit. Explain the purpose of each component, how the component works and why it is important.*

13.5 *Describe the normal operation procedures for the sludge conditioning unit components listed on page 73.*

13.6 *Perform the normal operation procedures for the sludge conditioning unit.*

13.7 *Describe and perform the start-up and shut-down procedures for the sludge conditioning unit.*

13.8 *Describe the abnormal operation procedures for the sludge conditioning process.*

13.9 *Describe the preventive maintenance procedures for the sludge conditioning unit.*

13.10 *Perform the preventive maintenance procedures for the sludge conditioning unit.*

13.11 *Describe the corrective maintenance procedures for the sludge conditioning unit components listed on page 73.*

13.12 *Perform the corrective maintenance procedures for the sludge conditioning unit components.*

13.13 *Perform the safety procedures for the sludge conditioning unit and demonstrate how they protect employees and visitors.*

13.14 *Compare other sludge conditioning units to the chemical conditioning unit with countercurrent elutriation (composite model plant unit M).*

13.15 *Name and locate the components of the sludge conditioning unit listed on page 73. Name and select reference materials which*

explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

13.16 Perform the abnormal operation procedures for the sludge conditioning unit.

RESOURCES: 3 116 120 125 141 143 144 307 308 309 316 317 320 321 324 421 459 511 551 552 553 554 937 990 1033 1034 1399

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OBJECTIVE 13.1: *Identify the sludge conditioning unit.*

CONDITIONS: Given a unit, a model of a unit or a photograph of a unit.

ACCEPTABLE PERFORMANCE: The student will:

Indicate whether the process unit is used for sludge conditioning.

INSTRUCTOR ACTIVITY:

1. Point out characteristics which distinguish the sludge conditioning unit from other process units.

STUDENT ACTIVITY:

1. Develop a picture file of sludge conditioning units. Mark distinguishing characteristics.

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OBJECTIVE 13.2: *Describe the sludge conditioning process in technical and nontechnical terms.*

CONDITIONS: Given photographs of the sludge conditioning unit.

ACCEPTABLE PERFORMANCE: The student will:

Describe the sludge conditioning unit, explaining the meaning of:
- chemical conditioning
- coagulation
- countercurrent elutriation

elutriation
flocculation
sludge conditioning

Describe the purpose of sludge conditioning.

Describe how sludge conditioning affects:
sludge dewatering
solids disposal
flow measurement
pumping and piping

INSTRUCTOR ACTIVITY:

1. Use diagrams, photographs and slides to describe sludge conditioning.
2. Describe the sludge conditioning process during a plant tour. React to the student's description of the process.

STUDENT ACTIVITY:

1. Describe the sludge conditioning process while viewing photographs, diagrams and slides.
2. Observe and describe the sludge conditioning process during a plant tour.

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OBJECTIVE 13.3: *Describe the safety procedures for the sludge conditioning unit and explain how the procedures protect employees and visitors.*

CONDITIONS: Given a list of operation and maintenance procedures.

ACCEPTABLE PERFORMANCE: The student will:

Describe the safety procedures for the sludge conditioning unit, commenting on:
High-risk activities
handling chemically coated equipment and components
lifting heavy objects
mixing chemicals
pressurizing chemical storage containers
removing debris from channels
walking in or near pits
working with switches in automatic position

Sources of danger
- acid wastes
- caustic wastes
- chemicals
- electrical equipment
- explosive gases
- ladders
- loose handrails
- moving parts
- open doors and covers
- pits
- rotating or oscillating equipment
- slippery floors and catwalks
- sludge
- stairs
- tanks
- welding torch
- wells

Safety equipment
- bicarbonate of soda solution
- boric acid solution
- eyewash stations
- face shields
- first-aid kit
- goggles
- hoisting apparatus
- lockout tags and keys
- protective breathing apparatus
- protective clothing
- railings
- safety showers
- stair safety treads

Explain how the procedures protect employees and visitors.

INSTRUCTOR ACTIVITY:

1. Discuss treatment plant case histories.
2. Describe the conditions in a plant and ask for evaluation.
3. Describe the safety procedures for each operation and maintenance procedure.
4. Prepare slides of sources of danger and high-risk activities.

STUDENT ACTIVITY:

1. Read case histories and comment on employee safety procedures.

2. Evaluate conditions which the instructor has described. Suggest remedies.
3. Role play operation or maintenance procedures. Select proper safety equipment and name the sources of danger and high-risk activities. Develop a manual of safety procedures for the sludge conditioning unit.
4. Identify sources of danger and high-risk activities pictured in slides.

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OBJECTIVE 13.4: *Identify the components of a sludge conditioning unit. Explain the purpose of each component, how the component works and why it is important.*

CONDITIONS: Given a sludge conditioning unit, unit components or a diagram, model or photographs of a unit and a list of components.

ACCEPTABLE PERFORMANCE: The student will:

Identify components of a sludge conditioning unit and associated equipment:

agitator	first-aid kit
bucket elevator	flight
chain	flowmeter
chemical conditioning tank	motor
chemical dry tank	overload alarm
chemical feed pump	pump
chemical feeder	rail
chemical storage	shaft
collector	shoe
control loop	slaker
coupling	speed reducer
elutriation tank	sprocket
fire-fighting equipment	valve

Explain the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out and name components in diagrams, photographs or models.
2. Arrange photographs or models of components in the workshop for student identification.
3. Point out and name components during a plant tour.

4. Question the students about the purpose of each component, how the component works and why it is important.

STUDENT ACTIVITY:

1. Identify the components which the instructor names on diagrams, photographs or models.
2. Identify the components at stations in the workshop in writing.
3. Identify components during a plant tour.
4. Explain the purpose of each component, how the component works and why it is important.

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OBJECTIVE 13.5: *Describe the normal operation procedures for the sludge conditioning unit components listed on page 73.*

CONDITIONS: Given a sludge conditioning unit or slides or photographs of a sludge conditioning unit, a list of components of the unit, a checklist of characteristics and a normal operation procedures manual.

ACCEPTABLE PERFORMANCE: The student will:

Describe the characteristics of each component which the operator checks to determine whether the component is functioning normally, commenting on:

color	position
corrosion	pressure
flow	sound
motion	temperature
odor	vibration

Name the sense or indicator which monitors each characteristic.

Explain how often the characteristics of each component must be checked and why the component must be checked on this schedule.

Describe what an operator does if the characteristics of a component indicate that it is not functioning normally, including:

- making adjustments
- deciding about corrective maintenance
- reporting to supervisors
- reporting in written records

Explain why a component's characteristics must be returned to normal.

Describe routine sampling for the sludge conditioning process.

List routine calculations for the sludge conditioning process.

Describe routine procedures for recording data.

INSTRUCTOR ACTIVITY:

1. Describe the characteristics of the components of the sludge conditioning unit.
2. Describe the normal operation procedures for the sludge conditioning unit. Use color pictures.
3. Describe the normal operation procedures during a slide show of components of the sludge conditioning unit.
4. Describe and explain the normal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Develop a checklist, listing the components of the sludge conditioning unit and their normal characteristics.
2. Develop a manual of normal operation procedures.
3. Describe the normal operation procedures during a slide show of components of the sludge conditioning unit.
4. Observe and describe the normal operation procedures during a plant tour.

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OBJECTIVE 13.6: *Perform the normal operation procedures for the sludge conditioning unit.*

CONDITIONS: Given a sludge conditioning unit, the manual of normal operation procedures which the student has developed for the sludge conditioning unit and basic references.

ACCEPTABLE PERFORMANCE: The student will:

Check and evaluate the characteristics of each component, explaining his actions.

Perform the procedures which an operator follows if the characteristics of a component indicate that it is not functioning normally.

Perform the routine sampling.

Perform the routine calculations.

Perform the routine record keeping.

INSTRUCTOR ACTIVITY:

1. Observe the student demonstrating normal operation procedures in a dry run in a treatment plant.
2. Observe the student performing normal operation procedures in a treatment plant.

STUDENT ACTIVITY:

1. Demonstrate the normal operation procedures in a dry run in a treatment plant.
2. Perform and explain the normal operation procedures in a treatment plant.

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OBJECTIVE 13.7: *Describe and perform the start-up and shut-down procedures for the sludge conditioning unit.*

CONDITIONS: Given a mock-up, model or photograph of a sludge conditioning unit and a sludge conditioning unit with the manufacturer's operation manual.

ACCEPTABLE PERFORMANCE: The student will:

Start up and shut down a sludge conditioning unit, following the manufacturer's instructions.

INSTRUCTOR ACTIVITY:

1. Demonstrate and perform the start-up procedures in a treatment plant.
2. Demonstrate and perform the shut-down procedures in a treatment plant.
3. Observe the student performing the start-up procedures in a treatment plant.
4. Observe the student performing the shut-down procedures in a treatment plant.
5. Observe the student as he evaluates his start-up procedures.
6. Observe the student as he evaluates his shut-down procedures.

STUDENT ACTIVITY:

1. Describe the start-up procedures in a dry run in a treatment plant.
2. Describe the shut-down procedures in a dry run in a treatment plant.
3. Perform the start-up procedures in a treatment plant.
4. Perform the shut-down procedures in a treatment plant.
5. Evaluate the operation of the sludge conditioning unit to determine whether correct start-up procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)
6. Evaluate the operation of the sludge conditioning unit to determine whether correct shut-down procedures have been used. Use the normal operation procedures manual which the student has developed. (See objective 1.4.)

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OBJECTIVE 13.8: *Describe the abnormal operation procedures for the sludge conditioning process.*

CONDITIONS: Given a wastestream in a treatment plant or color photographs of a wastestream, a checklist of the conditions of the wastestream and plant records and reference materials.

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

alkalinity	industrial wastes
chemical feed concentration	pH
flow	suspended solids

Describe the cause and effect of the abnormal condition.

Explain how often the condition of the wastestream must be checked.

Describe what an operator does if he observes abnormal conditions, including:

- operational changes
- reporting to supervisors
- sampling procedures

Describe how the actions of the operator will improve the condition of the wastestream.

INSTRUCTOR ACTIVITY:

1. Describe and explain the abnormal conditions of the wastestream illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures during a slide show.
4. Describe and explain the abnormal operation procedures during a plant tour. Listen to the student's description of the procedures.

STUDENT ACTIVITY:

1. Evaluate and explain the abnormal conditions of the wastestream which are illustrated in color pictures.
2. Describe and explain the abnormal operation procedures illustrated in pictures and described in plant records and case histories.
3. Describe and explain the abnormal operation procedures in a class discussion after a slide show.
4. Evaluate and explain the condition of the wastestream during a plant tour. Describe and explain the abnormal operation procedures.

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OBJECTIVE 13.9: *Describe the preventive maintenance procedures for the sludge conditioning unit.*

CONDITIONS: Given a sludge conditioning unit or pictures and drawings of a sludge conditioning unit and reference materials, including:

inspection records
manufacturer's maintenance guides
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Describe these preventive maintenance procedures for the sludge conditioning unit:

Cleaning
- bucket elevator
- chemical dry tank
- chemical feed pump
- chemical feeder
- chemical storage
- collector
- flight
- motor
- pump
- slaker

Lubrication
- agitator
- bucket elevator
- chain
- chemical feed pump

- chemical feeder
- coupling
- motor
- pump
- speed reducer
- valve

Mechanical adjustment
- agitator
- chain
- chemical feed pump
- chemical feeder
- flight
- flowmeter
- motor
- overload alarm
- pump
- shaft
- slaker
- speed reducer
- sprocket
- valve

Painting
- agitator
- chemical conditioning tank
- chemical dry tank
- chemical feed pump
- chemical feeder
- chemical storage
- elutriation tank
- motor
- pump
- slaker
- speed reducer

Replacement
- chain
- control loop
- fire-fighting equipment
- first-aid kit
- sprocket

Wear measurement
- chain
- coupling
- flight
- rail
- shaft
- shoe
- sprocket

Name the reference materials and tools needed to perform the preventive maintenance procedures.

Explain how often each preventive maintenance procedure must be performed.

Explain how an operator determines whether a component needs preventive maintenance.

Describe what an operator does if a component needs preventive maintenance.

Explain why each preventive maintenance procedure is important.

INSTRUCTOR ACTIVITY:

1. Describe and explain the preventive maintenance procedures for the sludge conditioning unit.
2. Describe and explain the preventive maintenance procedures during a slide show.
3. Describe and explain the preventive maintenance procedures during a plant tour.

STUDENT ACTIVITY:

1. Develop a preventive maintenance schedule and a manual of preventive maintenance procedures.
2. Observe, describe and explain the preventive maintenance procedures during a slide show.
3. Observe, describe and explain the preventive maintenance procedures during a plant tour.

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OBJECTIVE 13.10: *Perform the preventive maintenance procedures for the sludge conditioning unit.*

CONDITIONS: Given a sludge conditioning unit and tools and reference materials, including:

inspection records
manufacturer's maintenance guide
plant drawings and specifications
preventive maintenance schedule

ACCEPTABLE PERFORMANCE: The student will:

Select the reference materials and tools needed to perform the preventive maintenance procedures.

Apply the preventive maintenance schedule for the sludge conditioning unit, explaining his actions.

Perform the procedures which an operator follows when a component needs preventive maintenance, explaining his actions.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe student inspection of a treatment plant.
3. Observe the student performing the preventive maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform the preventive maintenance procedures in simulated situations in the workshop.
2. Inspect a treatment plant. Evaluate and explain the preventive maintenance procedures.
3. Perform and explain the preventive maintenance procedures in a treatment plant.

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OBJECTIVE 13.11: *Describe the corrective maintenance procedures for the sludge conditioning unit components listed on page 73.*

CONDITIONS: Given a sludge conditioning unit or a mock-up, photographs or drawings of a sludge conditioning unit, the manual of operation procedures which the student has developed for the sludge conditioning unit, tools and reference materials, including:

- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides

ACCEPTABLE PERFORMANCE: The student will:

Describe how an operator evaluates each component of the sludge conditioning unit for corrective maintenance, commenting on:

color	position
corrosion	pressure
flow	sound
motion	temperature
odor	vibration

Explain why a component has malfunctioned.

Name the reference materials and tools needed to perform the corrective maintenance.

Describe what an operator does when he discovers a malfunction, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Describe how the operator corrects the malfunction.

INSTRUCTOR ACTIVITY:

1. Describe and explain the corrective maintenance procedures for the sludge conditioning unit, using diagrams and pictures.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Describe and explain the corrective maintenance procedures during treatment plant tours.

STUDENT ACTIVITY:

1. Describe and explain the corrective maintenance procedures in situations described or pictured by the instructor.
2. Describe and explain the corrective maintenance procedures during a slide show.
3. Observe, describe and explain the corrective maintenance procedures during a treatment plant tour.

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OBJECTIVE 13.12: *Perform the corrective maintenance procedures for the sludge conditioning unit components.*

CONDITIONS: Given a sludge conditioning unit or unit components, the operation procedures manual which the student has developed, tools and reference materials, including:

- catalogue of replacement parts
- equipment catalogues
- manufacturer's maintenance guides
- manufacturer's operation manual

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the components of the sludge conditioning unit for corrective maintenance, explaining why a component has malfunctioned and commenting on:

color	position
corrosion	pressure
flow	sound
motion	temperature
odor	vibration

Select the reference materials and tools needed to perform the corrective maintenance.

Perform the procedures which an operator follows when a component malfunctions, including:

- evaluation of capabilities of plant personnel to perform the procedures
- selection of replacement parts
- record keeping

Correct the malfunction.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the components in a treatment plant.

3. Observe the student performing the corrective maintenance procedures in a treatment plant.

STUDENT ACTIVITY:

1. Small groups of students perform and explain the corrective maintenance procedures in simulated situations in the workshop.
2. Evaluate the components for corrective maintenance.
3. Perform and explain the corrective maintenance procedures in a treatment plant.

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OBJECTIVE 13.13: *Perform the safety procedures for the sludge conditioning unit and demonstrate how they protect employees and visitors.*

CONDITIONS: Given a list of operation or maintenance procedures, the student's manual of safety procedures, tools and safety equipment.

ACCEPTABLE PERFORMANCE: The student will:

Identify hazardous conditions in the sludge conditioning unit, commenting on:
high-risk activities
sources of danger
safety equipment

Explain how the procedures protect employees and visitors.

Recommend corrective procedures and correct the unsafe condition.

INSTRUCTOR ACTIVITY:

1. Set up simulated situations in the workshop.
2. Observe the student as he evaluates the safety conditions in a treatment plant.
3. Observe the student performing the safety procedures in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate safety conditions in simulated situations and recommend corrective procedures.
2. Evaluate safety conditions in a treatment plant and recommend corrective procedures.

3. Perform the safety procedures in a treatment plant.

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OBJECTIVE 13.14: *Compare other sludge conditioning units to the chemical conditioning unit with countercurrect elutriation (composite model plant unit M).*

CONDITIONS: Given a process unit and reference materials, including:
- equipment catalogues
- laboratory reports
- manufacturer's bulletins
- manufacturer's operation manuals
- plant maintenance and operation records

ACCEPTABLE PERFORMANCE: The student will:

Compare composite model plant unit M with:
- a multistage elutriation unit.
- a single stage elutriation unit.

Consider:
- availability of replacement parts
- capital costs
- dependency on surrounding environment
- ease of repair
- efficiency
- flow-handling capabilities
- maintenance costs
- nuisance to neighbors
- operational costs
- operational skills
- personnel requirements
- reliability
- resistance to upset
- sensitivity of controls
- space requirements
- waste-handling capabilities

INSTRUCTOR ACTIVITY:
1. Prepare a chart for tabulation of information about the units.
2. Compare composite model plant unit M with the other units.
3. Help the student to collect information for reports on the advantages and disadvantages of each unit.

STUDENT ACTIVITY:

1. List information about the units on a chart.
2. Compare the units in a panel discussion.
3. Write a report on the advantages and disadvantages of each unit.

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OBJECTIVE 13. 5:

Name and locate the components of the sludge conditioning unit listed on page 73. Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

CONDITIONS:

Given a sludge conditioning unit, unit components or a diagram, model or photographs of a unit and reference materials, including:

contractor's plans of the sludge conditioning unit
manufacturer's maintenance guides
operation and maintenance manuals

ACCEPTABLE PERFORMANCE:

The student will:

Name and locate the components of the sludge conditioning unit.

Name and select reference materials which explain the normal operation procedures, the purpose of each component, how the component works and why it is important.

INSTRUCTOR ACTIVITY:

1. Point out components of the sludge conditioning unit on diagrams, photographs or models.
2. Listen to the student naming the components and the applicable reference materials during a plant tour.
3. Name and display the reference materials which describe the sludge conditioning unit and normal operation procedures.

STUDENT ACTIVITY:

1. Name the components which the instructor points out on diagrams, photographs or models.
2. Name the components which the instructor points out during a plant tour and name the reference materials which apply to the components.
3. Name and select the reference materials which

describe the sludge conditioning unit and normal operation procedures.

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OBJECTIVE 13.16: *Perform the abnormal operation procedures for the sludge conditioning unit.*

CONDITIONS: Given a wastestream in a treatment plant and reference materials, including:

- industrial waste records
- operation logs
- operator manuals
- plant performance guides

ACCEPTABLE PERFORMANCE: The student will:

Evaluate the wastestream for abnormal conditions, commenting on:

- alkalinity
- chemical feed concentration
- flow
- industrial wastes
- pH
- suspended solids

Select the references he needs to return the wastestream to normal.

Perform the abnormal operation procedures.

INSTRUCTOR ACTIVITY:

1. Observe the student as he evaluates the wastestream in a treatment plant.
2. Describe the references needed to correct abnormal conditions of the wastestream.
3. Observe the student performing the abnormal operation procedures in simulated situations and in a treatment plant.

STUDENT ACTIVITY:

1. Evaluate the wastestream in a treatment plant.
2. Select the references needed to correct abnormal conditions of the wastestream.
3. Perform the abnormal operation procedures in simulated situations or in a treatment plant.

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